ECOSYSTEM STATUS INDICATORS

Ecosystem or Community Indicators

Biodiversity as Index of Regime Shift in the Eastern Bering Sea

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Many investigators have identified events in environmental and biological data from the North Pacific that indicate regime shifts, or reorganizations of the ecosystem at the environmental and biological level. Measurable climate events were identified in the mid-1970s, late 1980s, and the late 1990s that have been correlated with environmental phenomenon including Pacific Decadal Oscillation, El Niño Southern Oscillation, sea ice coverage, and summer time sea surface temperatures. The far reaching effect that climate change has on the ecosystem is not well mapped out, but many studies have shown strong correlations between climate change and recruitment of fish and invertebrates, and plankton production in the North Pacific. Biodiversity indices are robust measures for large ecosystem monitoring and possible indicators of regime shift phenomenon.

Data used for this study was collected by the Groundfish Assessment Program of the Resource Assessment and Conservation Engineering (RACE) Division, which surveys the eastern Bering Sea (EBS) shelf on an annual basis during summer (May-August). Use of biological survey data to monitor regime shifts is possible due to the consistent nature of this multispecies survey.

Biodiversity indices (richness and evenness) were used as indicators for species compositional changes over a 24-year period (1979-2002) and related the trends and changes evident with reported regime shift events in the EBS. Richness and evenness indices use the proportional biomass estimates of each assemblage to estimate a value that reflects the relative number of abundant species in the assemblage (richness) and the distribution of the species proportionalities (evenness).

For this analysis, two species guilds, flatfish and roundfish were identified, where the flatfish guild included all Pleuronectiformes recorded from the EBS survey (11 species or species groups), and the roundfish guild (40 species or species groups) excluding walleye pollock and Pacific cod due to their extremely large biomass. Biodiversity measures were calculated using Ludwig and Reynolds recommendations for species richness and evenness which are considered robust measures and allow the use of biomass estimate proportions for biodiversity indices.

A piecewise model was used to detect a break in the biodiversity time series, indicating a significant ecosystem change had occurred. Two linear models describe the biodiversity trends before and after a break (Figure 105). The data set for richness and evenness for each guild showed a continuous period of change from the late 1970s through the late 1980s, followed by a period of stasis until the present (Figure 105). The diversity indices suggest an event in the 1970s sparked ecosystem changes that were perpetuated into the late 1980s and early 1990s. The event in the late 1980s countered the 1970s event, and the system tended to stabilize at a new level from the early 1990s through 2002.

Biodiversity indices for the EBS fish guilds concur with the timing of a significant climactic event in the late 1980s. This study indicates that survey data can be used as a robust measure of large ecosystem change and corroborates shifts related to climate and environmental changes.

Given the greatly improved species identification levels and standardization now in use on the RACE groundfish surveys, assemblages can be studied which include more fish species and invertebrates.

Improved resolution of the species groups may detect more subtle changes in the ecosystem than previously possible.

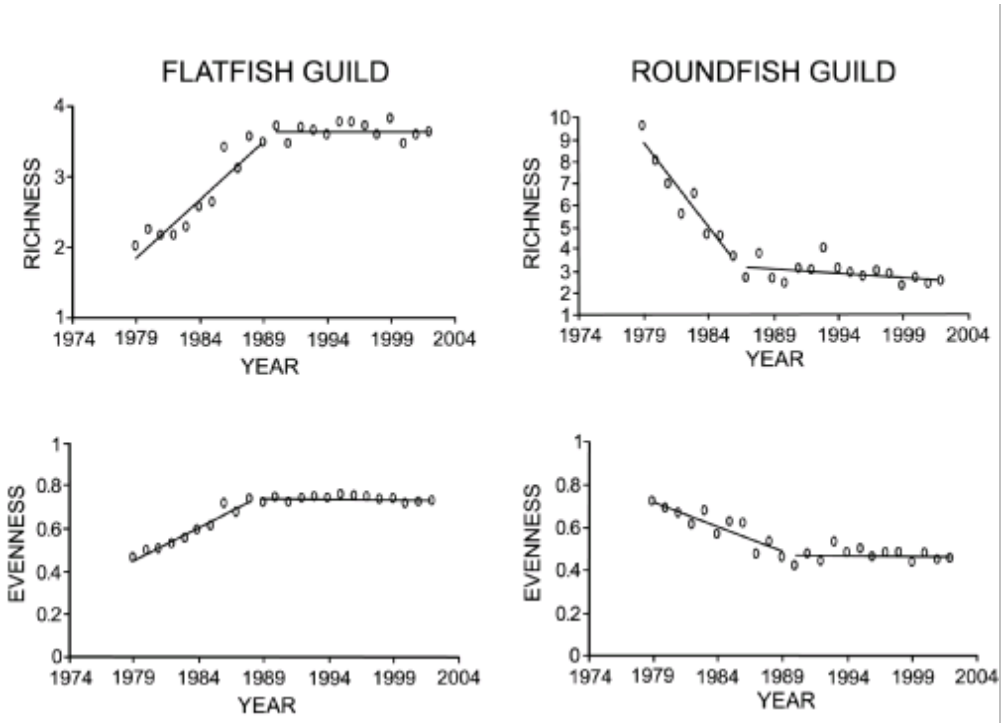

Figure 105. Plots of biodiversity (richness and evenness) indices for two fish guilds (flatfish and roundfish) from the eastern Bering Sea. Biodiversity showed a distinct shift in trends in the late 1980s which corresponds to reported regime shift events.